Effect of Processing on the Composition of Sesame Seed and Meal[1]

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Except for a variation in the free *epsilon*-amino lysine content of the protein, the Mexican screw-pressed meals were quite similar in their composition. The lysine values for sesame protein obtained for the solvent-extracted meals were much higher than those obtained for the screw-pressed meals. Screening of the endosperm and spermoderm from the solvent-extracted meals was effective in reducing the oxalate content of the resulting flour although some epiderm fragments passed through a 60-mesh screen. The decortication process completely removed the portion containing the oxalate from the seed and also reduced the calcium, sugar, and silica contents.

WHEREAS moderate heat, during the processing of many oilseeds for oil, may improve the nutritive quality of the meals, severe heating impairs the protein quality by inducing losses in amino acids. Major attention has been focused upon lysine damage since lysine is the limiting essential amino acid in many cereal and oilseed meal rations for nonruminants. Substantial losses in lysine during the processing of cottonseed (5), peanuts (3), soybeans (7), and sunflower (13) have been reported.

Effects of processing on sesame meal are of interest in comparison with the effects of processing on the meal and flour of cottonseed and peanuts. Of additional interest are the effects of processing on the oxalate content of sesame seed.

Sesame, *Sesamum indicum* L., a member of the *Pedaliaceae* family, is one of the world's most important food plants. The plant, cultivated in India for several thousand years, is grown extensively in tropical and subtropical areas of Asia, Mediterranean countries, and South America. Although hand labor is necessary in harvesting dehiscent or shattering varieties, the recent development of indehiscent strains adaptable to mechanized harvesting has increased interest in the commercial production of sesame in the southern area of the United States.

Fig. 1 shows a cross-section of a sesame seed with its histological structure (15). The seed, which is about 3 mm. long, flat, and pear-shaped, consists of three main parts: spermoderm, endosperm, and cotyledon. The outer epiderm of the spermoderm consists of a single layer of radially-elongated palisade cells which contain a mass of calcium oxalate crystals in the outer ends of the cells. The endosperm consists of two- to five-cell layers with thick rigid walls and is separated from the spermoderm by a membrane.

Experimental

The commercial sesame cake and meals obtained from Mexico were from seed processed by a dual screw-pressing method. The seed, after conditioning with live steam in a cooker, were prepressed by use of a three-section screw press to remove 25 to 50% of the oil. The resulting cake was conditioned in a five-high cooker; 3 to 5% moisture was added in the top ring of the cooker. It was then further processed by use of a screw press fitted with a 22-in. cage extension. The total cooking time was 90 min. for each lot of seed.

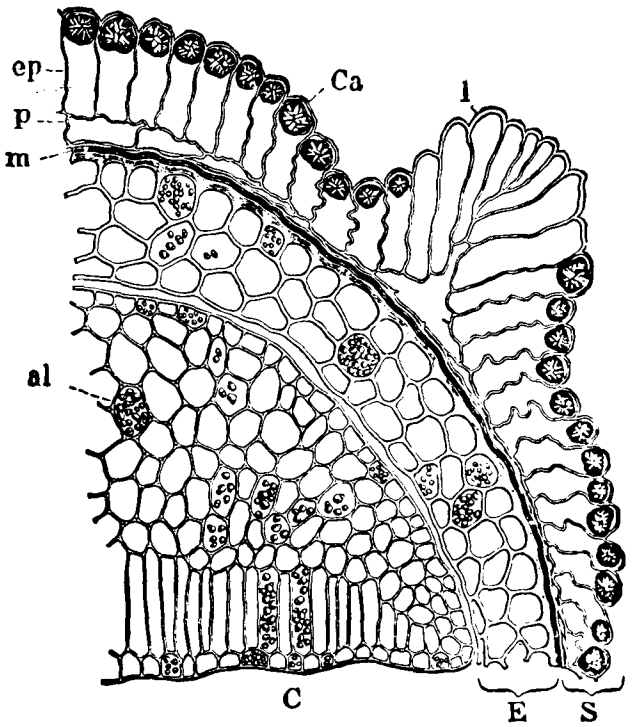

FIG. 1. Sesame seed cross-section. *S* spermoderm: *ep* outer epiderm with calcium oxalate crystal masses, *m* inner cuticle; *E* endosperm; *C* cotyledon. × 160. (A.L.W.)

Sample S-a had a maximum cooking temperature of 270°F. The temperature was lowered to 250°F. for sample S-b (Table I). These meals were ball mill-ground prior to analysis. Sample S-c was an additional commercial Mexican meal processed with a maximum cooking temperature of 270°F. It was prepared for analysis by hammer-mill grinding. Sample S-d represents the "fines" removed from meal S-c by means of an air-separator to reduce the fiber content.

Sample SIJMO was a commercial screw-pressed meal obtained from El Salvador for comparison.

Seed samples S-3 (tan indehiscent seed) and S-4 (decorticated S-3) were obtained from Texas. Samples S-5 (mixed white to black seed) and S-9 (Renner No. 1) were from Mexico. These four samples were flaked to a thickness of .010 in. to .012 in. by means of flaking rolls and were direct solvent-extracted at the ambient temperature with commercial hexane in the pilot plant of the Southern Regional Research Laboratory. The meal was oven-dried at 120–130°F. for 8 hrs. to remove the last traces of solvent.

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Since the endosperm was not broken when the seed was passed through the flaking rolls, both this tissue and the spermoderm were separated by simple screening from the flour derived from the cotyledons. The fractions of the solvent-extracted meals which were retained on a 40-mesh screen (SC-3, SC-4, SC-5, and SC-9) consisted mainly of spermoderm and endosperm particles. Sample SC-4 lacked the outer epiderm previously removed by the decortication process. The small amount of material retained on a 60-mesh screen was a mixture of cotyledon flour and finely-divided spermoderm-endosperm fragments. The material that passed through the 60-mesh screen (SF-3, SF-4, SF-5, and SF-9) were considered to be chiefly cotyledon flour, which consisted of approximately 50% of the extracted meal.

In general, the analytical methods employed were the official and tentative methods of the American Oil Chemists' Society (1) and the Association of Official Agricultural Chemists (2). The phosphorus methods used were those described by Pons, Stansbury, and Hoffpauir (11). The modified method of Stark and Hoffpauir for moisture in sesame seed was followed (14). Methionine was determined by the procedure of McCarthy and Sullivan (10), as modified by this laboratory to eliminate interferences. The method of Conkerton and Frampton was used to determine the free *epsilon*-amino group of lysine (4). Oxalate was determined by the procedure of Pucher *et al.* (12).

Results and Discussion

The analytical data obtained for the several preparations are recorded in Table I.

The commercial meals were similar in composition, ranging from 11.52 to 13.00% in ash, 1.45 to 1.68% in total phosphorus, 1.21 to 1.29% in phytin phosphorus, 5.29 to 6.88% in crude fiber, 2.27 to 3.07% in calcium, and 8.08 to 9.00% in nitrogen. In general, the analytical data for the meal from El Salvador are similar to those obtained with the Mexican meals, with the notable exception of the lysine content of the meal protein. The lysine content of SIJMO was high, and it was comparable to that found in the seed protein.

The lysine contents of the protein of the solvent-extracted meals were considerably higher than those of the Mexican screw-pressed meals. There was no apparent deleterious effect of decortication on the seed protein since the lysine content of the decorticated seed (2.8 g. per 16 g. of nitrogen) is essentially the same as that of undecorticated seed (2.7–2.9 g. per 16 g. of nitrogen). These values agreed with that of Lyman *et al.* (9), who found 2.76% lysine in sesame protein by microbiological assay.

The methionine content of the protein ranged from 2.45 to 2.75 g./16 g. nitrogen, which also agreed with the 2.65 value reported by Lyman.

Dey and Friedmann reported that 46.8% of the calcium in black seeds and 61.7% of the calcium in white seeds are present as the oxalate (6). The work of Gregoire and Carpiaux showed the ratio of calcium oxide to anhydrous oxalic acid to vary between 1.43 and 2.70 (8). However the oxalate contents for the decorticated sample S-4 and its fractions (SC-4 and SF-4) were zero. The calcium contents for these samples were also very low, indicating that most of the calcium was removed by the decortication process. Although samples SF-3, SF-5, and SF-9 were sieved, apparently enough epiderm fragments passed through to give a considerable, although reduced, oxalate content. Unfortunately no whole seed, S-3, was available for comparative analyses.

The reduction in sugar content can be readily explained by the decortication procedure. In this procedure the outer epiderm is broken and loosened from the seed which was swollen from the imbibition of water, in which the seed is suspended. The seeds are next transferred to a saline solution, the density of which permits the separation of the seed from the outer epiderm and other dense materials. They are then washed with water to remove the salt. Thus the lower values for sugar, calcium, oxalate, and silica obtained on the decorticated samples are due to the extraction of some materials in the seed and to the removal of the epiderm.

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TABLE I

Composition of Sesame Seed and Its Fractions

Sample	Moisture, %	Oil, %	Percentage calculated on a moisture-free, oil-free basis								Lysine, g./16 g. N	Methionine, g./16 g. N
			Ash	Crude fibers	Calcium	Oxalate	Phosphorus		Silica	Total sugars	Nitrogen	
							Phytin	Total				
Screw-pressed meals												
S-a	5.58	5.73	11.52	5.52	2.37	.....	1.27	1.54	.....	.....	9.00	2.3	2.45
S-b	6.09	9.64	11.61	5.29	2.49	.....	1.27	1.48	.....	.....	8.98	2.2	2.55
S-c	6.49	2.76	13.00	6.08	2.27	.....	1.25	1.45	.....	.....	8.54	1.9	2.60
S-d	5.28	4.97	11.93	6.88	2.36	0.86	1.21	1.45	1.75	4.03	8.60	1.8	2.50
S-e (SIJMO)	7.35	8.49	12.55	6.22	3.07	0.81	1.29	1.68	0.51	4.29	8.08	2.8	.....
Seeds													
S-3 [a]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
S-4 (decorticated) (S-3)	4.37	60.15	8.40	.....	0.20	0.0	1.61	2.11	0.0	.....	11.47	2.8	.....
S-5	5.09	51.47	9.53	.....	2.33	2.07	0.90	1.29	0.18	.....	8.86	2.7	.....
S-9	4.69	53.36	11.11	.....	2.19	1.86	1.27	1.81	0.07	.....	8.13	2.9	.....
Seed coat fraction													
SC-3	9.45	3.36	8.68	11.19	2.93	1.77	0.41	0.78	0.19	5.02	6.39	2.7	.....
SC-4	10.03	3.97	5.28	12.49	0.23	0.0	0.77	1.25	0.01	2.73	9.84	2.4	.....
SC-5	8.36	8.17	8.73	10.69	3.47	2.22	0.36	0.58	0.04	3.81	6.47	2.5	.....
SC-9	8.43	5.84	9.07	10.61	2.40	1.52	0.80	1.23	0.08	5.46	7.22	2.7	.....
Flour fraction													
SF-3	9.04	0.89	11.28	3.10	1.08	0.59	1.86	2.08	0.45	5.91	10.41	2.8	2.60
SF-4	10.20	0.59	10.45	2.69	0.18	0.0	2.36	2.56	0.03	1.55	12.82	2.7	2.50
SF-5	8.72	0.88	10.50	2.99	1.60	0.99	1.61	1.74	0.24	4.19	10.85	2.7	2.55
SF-9	8.53	1.57	13.17	3.69	1.88	1.34	2.19	2.38	0.21	6.23	9.62	2.8	2.75

[a] Sample not available for analysis.

for pilot-plant extraction of the seed; and to V. L. Frampton for his suggestions and encouragement.

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Third Interim Report of the A.O.C.S.-A.O.A.C. Crude Fiber Liaison Committee, 1959-1960

THE SECOND INTERIM REPORT of the Crude Fiber Liaison Committee was presented at the October 1959 meetings of the American Official Agricultural Chemists, published in full in the Journal of the American Oil Chemists' Society (1), and summarized in the Journal of the A.O.A.C. (2). This report covered a collaborative study by the committee, utilizing four different methods for filtering the crude fiber after the digestion. It was concluded that none of the filtering devices tested showed sufficient advantage in accuracy or precision to warrant selection as a standard procedure. The Crude Fiber Committee however agreed that the screen was preferable to the cloth as a filtering medium. This limited the selection to the Oklahoma State Filter Screen and a new device submitted by Mr. Entwhistle of the California State Department of Agriculture and designated as the California State Modified Buechner Funnel. This device consists of a two-piece, 7-cm. diameter, polyethylene Buechner Funnel, into which a 200-mesh stainless steel screen has been heat-sealed. The device appeared to incorporate all of the desirable features of the Oklahoma State Filter Screen, the Buechner Funnel Method, and the Purdue Method. Because of these interesting features the committee decided to conduct another collaborative study, comparing the California State Modified Buechner Funnel against the Oklahoma State Filter Screen.

Twelve laboratories participated in this study, and six samples were submitted, including meat scraps, yeast, 44% soybean oil meal, cottonseed meal, mixed feed, and alfalfa. The A.O.C.S. statistical design was used, giving a total of 48 results from each laboratory for a grand total of 576 results. The results of this study are summarized in Table I; each figure shown is an average of four determinations.

A statistical analysis was made of these results. The standard deviations and 95% confidence limits obtained on each sample are shown in Table II. It will be noted that the yeast and alfalfa samples show standard deviations considerably higher than any of the other products analyzed. Yeast is normally difficult to analyze for fiber, and it is not surprising that precision obtained on this sample was poor. Likewise high fiber content of the alfalfa sample will affect the precision. In drawing conclusions on the adaptability of the method, these two samples might logically be eliminated.

Table III expresses precision of the methods on the basis of a 95% confidence limit. In addition to the results obtained in this collaborative study, we have included in Table III the results of the previous collaborative study as reported in the Second Interim Report.

A serious disadvantage to both the Oklahoma and California Method is the relatively large quantities of asbestos which must be employed to obtain rapid and efficient filtration. Preliminary investigations by some of the collaborators gave evidence that there is a loss in weight in the asbestos during the incinera-

TABLE I

Collaborative Data Comparing Oklahoma Filter Screen with California State Modified Buechner Funnel

Laboratory	Meat scraps		Yeast		S.B.O.M.		Cottonseed meal		Mixed feed		Alfalfa meal	
	O[a]	C	O	C	O	C	O	C	O	C	O	C
1	2.10	2.25	4.06	4.61	6.34	6.12	12.17	12.14	4.92	5.12	24.61	24.00
2	2.10	2.14	4.63	4.50	6.04	5.70	11.01	11.78	4.91	5.00	24.67	24.73
3	2.21	2.47	6.33	6.46	6.61	6.63	12.23	12.24	5.27	5.30	25.44	25.48
4	2.03	2.18	5.63	5.70	5.98	6.10	11.60	11.35	4.85	4.85	24.60	24.25
5	1.88	2.05	3.05	4.48	6.00	6.10	11.45	11.50	4.85	5.05	24.43	24.65
7	1.93	2.13	4.04	4.18	6.10	6.28	12.25	12.05	4.94	4.83	24.11	24.34
8	1.99	2.09	4.64	5.13	6.18	6.10	11.69	11.41	4.93	4.99	24.40	24.22
9	2.17	1.91	4.56	5.09	6.13	5.89	11.62	11.24	4.84	4.78	24.59	24.42
10	2.14	2.15	5.13	4.85	6.25	6.24	11.90	11.70	5.18	5.23	25.23	25.33
11	2.00	1.91	3.90	4.03	6.08	5.85	11.81	11.17	5.04	4.93	24.57	24.16
12	2.18	2.33	5.86	5.63	6.62	6.81	11.79	12.16	4.95	5.23	24.65	24.84
13	1.85	2.08	4.63	6.15	5.98	6.15	11.30	11.75	4.85	5.18	23.63	24.88
$\bar{x}$	2.05	2.14	4.69	5.07	6.15	6.16	11.80	11.71	4.96	5.05	24.57	24.66

[a] O—Oklahoma Filter Screen. C—California State Modified Buecher Funnel.
Note: Each result shown is the average of four determinations.